Wood heat treatment modifications: effects of initial moisture and air exchange rate on kinetic and final product characteristics

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Final Cost Action FP0904 Conference

"Recent Advances in the Field of TH and THM Wood Treatment"

May 19-21, 2014, Skellefteå, Sweden

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Book of Abstracts

Organized By:

- **Luleå University of Technology, Skellefteå,**
- **Division of Wood Technology and**
- **COST Action FP0904**
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Preface

Book of abstracts includes the scientific program and the abstracts of papers will be presented at the Final COST Action FP0904 Conference on "**Recent Advances in the Field of TH and THM Wood Treatment**" at the **Luleå University of Technology**, Division of Wood Science and Engineering, in Skellefteå, Sweden on 19–21 May 2014.

The main objective of COST Action FP0904 is to achieve a better understanding on mechanical and chemical transformations of wood during Thermo-Hydrous (TH)/ Thermo-Hydro-Mechanical (THM) processing through collaborations between different researchers from the wood and material sciences. This Action provides cooperation and encourages research between research groups from academia and industry to help to overcome the challenges in scaling-up research findings, improving full industrial production, process improvement, in understanding the relations between the processing parameters, material properties and the development of new products. The COST Action FP0904 consists of three Working Groups (WGs):

WG1: Identification of chemical degradation of wood under Thermo- Hydrous treatment
WG2: Modelling of Thermo-Hydro-Mechanical behaviour of wood during processing
WG3: Innovation and new products by Thermo-Hydro-Mechanical processing

We wish the conference provides a forum and an opportunity for experts and young researchers from worldwide academia and industry to present their latest research, exchanging and developing new ideas within the field of TH and THM wood treatment. The objectives of this conference are to present and discuss the state-of–the-art of TH/THM wood treatment in open and closed systems and the challenges in wood characterization and scaling-up from laboratory to full industrial production, through a discussion of the latest research results and new ideas. The key objective of this Final Action FP0904 Conference is to present the main results of the Action, to summarise the scientific progress achieved and to formulate open questions and further challenges. This conference will include an evaluation session with representatives of COST and Action Management Committee members.

Luleå University of Technolgy (LTU), established in 1971, is the northernmost University of Technology in Scandinavia and is known for its education and research within the field Wood Science and Engineering. The research area of Wood Technology, Wood Physics and Wood Products Engineering is since 1982 established in the city of Skellefteå. Northern Sweden is one of the most important areas in Europe when it comes to forestry and the wood industry. The Wood Science and Engineering group at LTU are engaged in a wide range of fields within the entire chain from forest to finished product.

On behalf of the COST Action FP0904 Management Committee I would like to thank everybody that kindly contributed to this meeting: all the authors and specially the keynote speakers; Callum Hill, Eiichi Obataya, Otto Th. Eggert and Kevin Candelier.
I gratefully acknowledge the help of the Scientific Advisory Committee in reviewing the abstracts and preparing the scientific program.
I express my sincere gratitude to Dick Sandberg and Mojgan Vasiri for their works in preparing the "book of abstracts" and also as the local organizer.

Parviz Navi
Chair of COST Action FP0904

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DATE	18-21 MAY
VENUE	Arenan at Campus Skellefteå
OFFICIAL LANGUAGE	The official conference language will be English.
BADGE	Delegates must report to the registration desk to collect their name badges and conference materials. Every participant including his/her accompanying person is requested to wear a name badge during theconference period. Venue **:** Lobby Arenan The desk will also be operating during the following schedule
REGISTRATION	18 May Sunday 14:00-16:30
RECEPTION DESK	18 May Sunday 14:00-16:30 19 May Monday 07:20-11:30 20 May Tuesday 08:00-08:40 21 May Wednesday 07:30-11:00
SPEAKER'S RECEPTION DESK	Regarding Oral Presentations, please note that: It is expected that all presentations will be presented in English using Microsoft PowerPoint with a common computer provided by the conference organizers. We encourage you to check your PowerPoint file compatibility in advance. An overhead projector will be available by special request. **IMPORTANT!** All speakers are required to check in at the Speaker's Reception Desk by 18 & 19 May in order to hand over the CD or USB with the PowerPoint file, to be downloaded on the conference computer. All speakers during Tuesday **must** hand in their presentations during Monday May 19. The opening times for the Speaker's Reception Desk are the same as for the Information Des, Sunday 14:00-16:30 and Monday 7:20-11:30. During Tuesday and Wednesday only by request in advance, (please contact the General Information Desk for further assistance)

Time	SUNDAY MAY 18	Time	MONDAY MAY 19	Time	TUESDAY MAY 20	Time	WEDNESDAY MAY 21
		07:20-08:20	Registration	09:00-9:30	**Session 3**: New products by THM-open system **Keynote 3: Otto Th. Eggert**	08:00-08:30	Coffee
		08:20-08:40	Opening session	09:30-10:30	3 Full Oral Presentations	08:30-10:30	Management Committee Meeting and the Evaluation Panel (Closed session)
		08:40-09:20	**Session 1**: Chemical degradation of wood under thermo-hydrous treatments **Keynote 1: Callum Hill**	10:30-11:00	Coffee Break		
		09:20-10:00	2 Full Oral Presentations	11:00-11:40	2 Full Oral Presentations		
		10:00-10:30	Coffee Break	11:40-12:00	5 Poster Presentations		
		10:30-11:10	2 Full Oral Presentations	12:00-13:30	Lunch		
		11:10-11:30	6 Poster Presentations	13:30-14:10	**Session 4:** Innovations and new products laboratory and industrial scale & STSM presentations **Keynote 4: Kévin Candelier**		
		11:30-13:00	Lunch	14:10-15:10	3 Full Oral Presentations		
		13:00-13:40	**Session 2**: Modeling of THM processing and predicting the behavior of THM **Keynote 2: Eiichi Obataya**	15:10-15:40	Coffee Break		
		13:40-14:20	2 Full Oral Presentations	15:40-17:18	8 Oral Presentations & 2 Poster Presentations		
		14:20-14:50	Coffee Break	19:00-22:00	Conference Dinner		
14:00-18:30	Registration And Welcome Reception	14:50-15:50	3 Full Oral Presentations				
		15:50-16:13	7 Poster Presentations				
		16:15-18:00	Posters & Visit To LTU Laboratory				

	SUNDAY **MAY 18TH**
14:00-18:30	**Registration And Welcome Rception**
	MONDAY **MAY 19TH**
07:20-08:20	**Registration At the Desk (Conference Place)**
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WEDNESDAY MAY 21TH	
08:00-08:30	Coffee
8:30-10:30	Management committee meeting with the COST representative and the evaluation panel (Closed Session)

Abstracts

Wood heat treatment modifications: effects of initial moisture and air exchange rate on kinetic and final product characteristics

Giacomo Goli, Bertrand Marcon, Marco Fioravanti

Dipartimento di Gestione dei Sistemi Agrari, Alimentari e Forestali (GESAAF),
Università di Firenze,
Via S. Bonaventura 13, 50145 Firenze, Italy

giacomo.goli@unifi.it

Keywords: heat treatment kinetic, air exchange rate, time-temperature equivalency, rheology, wood properties

This contribution aims to present the kinetic of heat treatment as well as the effect on some physical and mechanical properties of poplar wood (*Populus alba* L.). Some tests were performed at different treatment temperatures from 180ºC to 260ºC. Moreover two different air ventilation settings qualified as low and high air exchange rate (*AER*) with the exterior were applied during the treatments.

The treatment kinetic is studied, starting from the oven dry state condition, by following the mass loss during time and highlighted a possible time-temperature equivalency, see Figure 1 (increasing the temperature has the same effect than treating for a longer time).

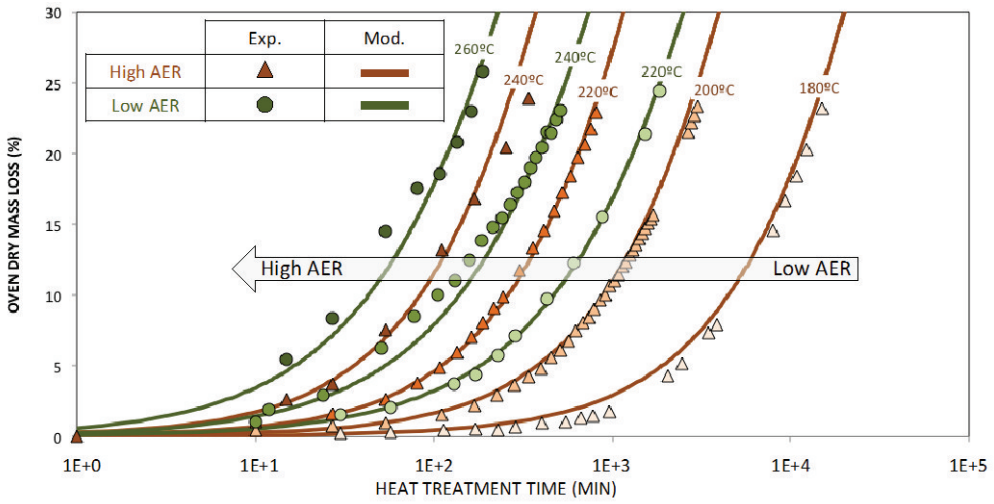

Figure 1. *Mass loss during heat treatment at different temperatures and different air exchange rates (low and high AER). The markers are the experimental points and the plains lines are the model outputs for each condition. The horizontal time-axis is in logarithmic scale*

The complete analysis of the kinetic, using for instance the complex plot (Cole-Cole) to avoid the time parameter and evaluate the model parameters [1], supports the Time-Temperature Superposition Principle [2]. The mass loss *versus* time is formalized through a power law arsing from rheological considerations and a master curve of the heat treatment build. The Arrhenius law was checked and used to achieve the complete formulation including the temperature and the time effects [3]. This work clearly evidences how the heat treatments at low or at high *AER* presents different kinetics even if almost similar activation energy values are found.

In addition, some physical and mechanical properties of wood after treatments performed up to a mass loss of 7 and 10% and starting from oven dry state or standard environmental conditions were measured. All the treated samples have shown statistically significant differences compare to the untreated one. The statistical analysis have shown how the treatments performed starting at dry or wet condition up to a dry mass loss of 7 and 10% present very similar effects on almost all the analysed parameters except *MOE*. For *MOE* in fact starting the heat treatment from the wet condition results in a lower reduction if compared to heat treatment started from the oven dry state condition.

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